# FY14 Application for Nursery Research Funding
## Washington State Department of Agriculture - Nursery License Surcharge

14-006

**(Please use one application packet including the Progress Report page for each proposal. You must use our form - *failure to do so may result in not funding your project*.)**

**Project Title:** Developing Struvite as a Fertilizer for Container-Grown Nursery Crops

**Project Leader:** Rita L. Hummel

**Institution (if any):** Washington State University Puyallup

**Mailing Address:** 2602 W Pioneer, Puyallup WA 98371

**Email:** hummelrl@wsu.edu

**Project Phone Number:** (253)445-4524 **Cellular/Pager Number:** (253)202-1915

**Note: Project leader or his/her designee must be available at above project phone number on** March 1, 2013 **between the hours of 10:00-12:00 and 1:00-3:00.**

**Amount Requested for (FY13) July 1, 2013 to June 30, 2014:** $33,068

**Start Date:** July 1, 2013 **Completion Date:** June 30, 2015

***(Check One) New Project*** X ***Continuing*** ____

If this is a multiple year project, please estimate and list the following information for each future July 1 - June 30 period listed below through project completion:

| Fiscal Years (FY) | July 1, 2013 to June 30, 2014 | July 1, 2014 to June 30, 2015 | July 1, 2015 to June 30, 2016 | July 1, 2017 to June 30, 2018 | July 1, 2018 to June 30, 2019 |
|---|---|---|---|---|---|
| $ Amount Needed | $33,068 | $34,910 | | | |

If you are increasing the above amounts since your last application, please explain why:

*Please list **all** other sources and amounts of funding for this project for the current year only: **(Please notify us by March 1st if other funding has been approved and from where.)**

| Source | $ Amount Applied For | Approved | Pending Date of Notification |
|---|---|---|---|
| Small Business Innovation Research, Multiform Harvest Inc. | $50,000 | $50,000 | |
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**Total Amount Needed to Fund Project (Include all sources)** $117,978

**If total amount from all sources is not granted, will you be able to complete the project?** Not as described
**Explain:**
The greenhouse crop production in peat substrates research is funded and will proceed. The nursery crop production in bark substrates research will not be done without funding for a graduate student.

**Submit 16 copies of this proposal to: Tom Wessels, Plant Services Program Manager, P.O. Box 42560, Olympia, WA 98504-2560, twessels@agr.wa.gov, or fax (360) 902-2094. All applications must be postmarked by December 31, 2011.**

**Please summarize the purpose of this research: (you may attach additional sheets if necessary or submit this summary in your own format)**

Container-crop production practices call for the frequent addition of water and fertilizers to soilless media to produce high value crops (Biernbaum, 1992; Wright and Niemiera, 1987). The soilless growing media typically used for producing greenhouse and nursery crops in containers are deficient in phosphorus. It is a standard production practice to incorporate phosphorus, typically superphosphate, into the growing media prior to potting most container-grown plants. Struvite (ammonium magnesium phosphate) is a by-product of wastewater treatment and research has shown it has potential to serve as a phosphorus source for plants grown in containers (Johnston and Richards, 2004; Hummel and Cogger, 2012). A production system that utilizes struvite from wastewater would enhance the nutrient use efficiency and sustainability of container crops.

Project Objective. This research will compare mined triple superphosphate with struvite produced from dairy manure for its efficacy as a fertilizer source for producing woody nursery crops in a Douglas-fir bark substrate. Plant growth in response to struvite will be evaluated by measuring shoot and root growth, quality, and leaf color of an evergreen and a deciduous shrub in comparison to plants grown with the traditional phosphorus source. This research will complement a greenhouse research project that was recently funded by the Small Business Innovation Research (SBIR) program to assist Multiform Harvest Inc. with development of dairy manure struvite as a commercially viable fertilizer for container plant production in peat-based substrates in the greenhouse environment (see attached letter of support from Multiform Harvest Inc.).

The objective of this research is to evaluate struvite as a phosphorus fertilizer for producing woody nursery crops out-of-doors in a Douglas-fir bark substrate. If awarded, the funding would be used to support a half-time horticulture graduate student on a Master of Science Research Assistantship to work on the project. The research will proceed in two phases. In phase one, plant growth in response to container substrates, struvite formulation and rate will be measured in an effort to optimize struvite fertilization practices. In the second phase an optimal struvite treatment will evaluated for its effect on nutrient content of plant tissue, growth substrate and water quality. Capture and use of phosphorus from wastewater is a sustainable practice with potential benefits to the environment and to producers of container-grown plants.

**Methods of research:**

Phase One

*Nursery Production.* Rooted liners of a broadleaved evergreen shrub (rhododendron) and a deciduous shrub (like lilac) will be obtained from a commercial propagator and transplanted into 1 gallon containers. The potting substrates will be 100% Douglas-fir bark and a mixture of Douglas-fir bark and peat moss at approximately 80% bark:20% peat by volume.

The most promising struvite product(s) will be applied to each potting mix. Methods of application will include: 1) incorporate by thorough mixing with the growth substrate; 2) top dress on the surface of the growth substrate and 2) dibble by applying directly beneath the plant roots. Rates of phosphorus from struvite will be based on the recommended rate of P from a traditional potting mix additive like superphosphate. A micronutrient fertilizer will be incorporated in all treatments. In a preliminary greenhouse study comparing incorporation of triple superphosphate at the commonly recommended rate of 1 pound per cubic yard with struvite at 0.5, 1 or 1.5 times the recommend rate, Hummel and Cogger (2012) found there was no significant difference in growth or quality of marigold or pepper plants.

After transplant, fertilizer solutions will be surface applied weekly at two P rates. Nitrogen (N) and potassium (K) will be applied at a uniform rate to all plants at each P application. Thus all plants will receive the same amount of N and K; only the P rate will vary. The fertilizer solutions will be prepared using combinations of ammonium nitrate, potassium sulfate, and potassium phosphate monobasic. Each treatment will be applied to two plant species and replicated six times for each species and treatment combination.

Tests will be conducted to measure initial pH, electrical conductivity (EC), water-holding capacity (WHC), and aeration porosity (AP) of the growing medium. Medium pH and EC will be determined using the 1:5 method (Thompson et al., 2001). WHC and AP will be determined by following the volume measurement technique described by Ingram et al. (1990).

*Plant Growth and Quality.* Plant growth and quality will be measured by recording initial plant height and the narrowest and widest canopy widths at transplanting and comparing with stem height and the widest and narrowest canopy width at the end of the production cycle. A shoot growth index (SGI) will be calculated from this data as follows: ((widest width + narrowest width)/2 + height)/2.

At the end of production, visual shoot quality of all plants will be rated on a scale ranging from 5: a superior plant, to 1: a poor quality plant, with a rating of 3 considered salable. Leaf color will be quantified using a Minolta Chroma Meter. Root growth, as root length and root density, will also be rated. Root length will be rated from 4: roots circling the bottom of the container, to 1: roots growing half-way to the container bottom. Root density will be rated from 4: solid root mass with little or no growing medium visible at the periphery, to 1: no roots visible at the periphery. Plants will be cut at the medium surface and the shoots dried for 96 hours at 60°C (140°F) in a forced air oven, then shoot dry mass will be determined. Analysis of variance (PROC GLM) will be used to test the significance of growing media and fertilizer rates (SAS 8.1, SAS Institute Inc., N.C.).

<u>Phase Two</u>

Results from Phase One will inform the selection of two optimal struvite treatments for Phase Two. The treatments will be applied, plants grown and plant data collected as described in Phase One.

In addition to plant growth measurements, a preliminary analysis of the optimal struvite treatments will be conducted to determine their effect on nutrient distribution, with emphasis on phosphorus, on plant tissue, growing medium and water. Determination of phosphorus and other nutrient contents will be performed by sending media, water and plant tissue samples to a commercial laboratory for analysis. Plant tissue will be tested for major and microelements (Total N, P, K, Ca, Mg, Cu, Zn, Mn, Fe, B, Na, and S), potting media will be tested for major elements and water testing will focus on phosphorus and nitrogen.

Phosphorus leaching potential will be evaluated by measuring point-in-time P content in water leached through the containers following one or two irrigation events. Residual P in the soilless growing medium will be determined by measuring its P content at end of the production cycle. Plant uptake of phosphorus, magnesium and other nutrients will be determined by drying plant tissue, grinding, and sending samples to a commercial laboratory for nutrient analysis. Data analysis will be conducted as in Phase One.

Information gained from this project will benefit the environment and all that depend on the environment by capturing and putting to beneficial use the plant nutrients, especially phosphorus that are currently a waste product with the potential to pollute. Results will be shared via articles in scientific and trade publications; an Extension bulletin, presentations at industry seminars, trade shows and workshops; on-site tours, and web information.

**References:**

Biernbaum J. A. 1992. Root-zone management of greenhouse container-grown crops to control water and fertilizer use. HortTechnology. 2:127-132.

Hummel, R.L., and C. Cogger. 2012. Struvite can serve as a renewable phosphorus source for greenhouse crop production. The B&B Magazine. 64:16-17.

Ingram, D.L., R.W. Henley, and T.H. Yeager. 1990. Diagnostic and monitoring procedures for nursery crops. Univ. of Fla. Coop. Extn. Serv. Circ. 556.

Johnson, A. E. and I.R. Richards. 2004. Effectiveness of different precipitated phosphates as phosphorus sources for plants. Phosphorus Research Bulletin. 15:52-59.

Thompson W.H, Leege, P.B., Millner, P.D., Watson, M.E. Test methods for the examination of composting and compost. USDA: 2001.

Wright, R.D and A. Niemiera. 1987. Nutrition of container-grown woody nursery crops. Horticultural Reviews. 9: 75-101.

**Expenditure Breakdown:**
**(Please include salaries, supplies, travel, etc.)**

| | Year 1 | Year 2 |
|---|---|---|
| Graduate Student Research Assistantship<br>50% Appointment, Master of Science Degree | $33,068 | $34,910 |
| Two year Total | $ | 67,978 |

**<u>The information requested on this page will have a direct bearing on whether your research request is approved or denied. Letters of support by the industry are also encouraged.</u>**

**Note: Funding is not available for general overhead cost.**

MULTIFORM HARVEST

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December 21, 2012

Tom Wessels
Plant Services Program Manager
Washington State Department of Agriculture
P.O. Box 42560
Olympia, WA 98504-2560

Dear Mr. Wessels:

Multiform Harvest Inc. ("Multiform") enthusiastically supports the project "Developing Struvite as a Fertilizer for Container-Grown Nursery Crops" being submitted by Dr. Rita Hummel of Washington State University (WSU). Multiform and WSU have partnered for nearly ten years in the development of technology to extract excess phosphorus from dairy and other wastewaters in the form of struvite and in the evaluation of the struvite product as a fertilizer. In that time, Multiform has commercialized the extraction process, with full-size plants in Washington State, Idaho, and a third under contract in Maryland. The plants are producing raw struvite, which Multiform is now selling primarily as a substitute for mined phosphate products.

Struvite has special characteristics that allow it to deliver phosphorus more efficiently and safely than do other phosphorus fertilizers. Therefore, it can provide extra benefit to growers and also offers a double environmental benefit: (1) extraction of phosphorus from the wastewaters reduces phosphorus releases to the environment resulting from the wastewater; and (2) more efficient delivery by the struvite fertilizer reduces losses to the environment at the locations where the struvite is used. However, development and marketing of upgraded products that capitalize on these characteristics require skillful testing of products' efficiency and other performance parameters. Multiform lacks the ability to undertake these tests and thus highly values WSU's expertise in this area. The evaluations proposed by Dr. Hummel will be crucial in bringing struvite's special benefits to the container-grown nursery plant sector.

Sincerely,

Keith Bowers

Keith E. Bowers, PhD
President